

In re Patent Application of:

LANG ET AL

Serial No. 10/701,258

Filed: 11/04/2003

REMARKS

Claims 1-6 and 8-27 are pending. The specification has been amended to obviate objections thereto raised in the outstanding Final Office Action. Reconsideration of the present application in light of the foregoing amendments and following remarks is respectfully requested.

Specification

By the foregoing amendment, a substitute specification has been submitted to ensure correct paragraph replacement for the amended specification as the amendments to the specification mailed on 14 March 2006, in reply to the previous Office Action of 14 November 2005, erroneously requested paragraph replacement based on paragraph numbering of the application publication, instead of the original application as filed. In the amendment mailed on 14 March 2006:

Replacement paragraph [0023] should have been paragraph [22]
Replacement paragraph [0038] should have been paragraph [37]
Replacement paragraph [0042] should have been paragraph [41]
Replacement paragraph [0045] should have been paragraph [44]
Replacement paragraph [0050] should have been paragraph [49]
Replacement paragraph [0051] should have been paragraph [50]
Replacement paragraph [0053] should have been paragraph [52]
Replacement paragraph [0054] should have been paragraph [53]
Replacement paragraph [0058] should have been paragraph [57]
Replacement paragraph [0063] should have been paragraph [62]

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Paragraph numbering in the remarks will reference the actual paragraph of the original specification as filed, not the published application, with the exception of the quote from paragraphs 3 and 4 of the Examiner's comments in the Office Action mailed June 16, 2006.

Drawings

Acceptance of the drawings in item 1, on page 2 of the outstanding Office Action is acknowledged.

Objections to the Specification under 35 U.S.C. § 132(a)

With respect to the objections to the specification, the following comments are offered.

Paragraphs 3 and 4 of the outstanding final Office Action allege that new matter has been introduced by the amendment filed 3/14/06 as follows:

- "3. Paragraph [0051] the output beam of figs 3a and 3b is high power.
4. Paragraph [0053] 175 is an infrared dump beam."

With respect to the statement in paragraph 3 of the outstanding office action, please note that paragraph [50] of the original specification, as previously amended, reads (wording added by the amendments filed 3/14/06 is underlined) as follows:

Another aspect of the present invention provides a frequency-converted laser apparatus comprising the Littrow-stabilized laser diode of the first aspect of the present invention optically coupled to an out-of-cavity

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nonlinear element to produce frequency-converted coherent radiation from the laser output beam 140. According to this aspect of the invention, the laser output beam 140 is preferably a high-power beam as described hereinafter, and will also be referred to herein as the high-power beam 140 in the context of the frequency conversion.

Contrary to the allegation of new matter, nowhere does the amended wording or the original wording of paragraph [50] of the original specification refers to the output beam of the systems shown in figs 3a and 3b; instead, it clearly refers to beam 140, which is referred to as a "high-power" beam in the text of the application as originally filed. This beam is the output beam of "the Littrow-stabilized laser diode". The Littrow-stabilized laser diode according to the present invention is shown in original Figs. 2, 2a, and Figs. 6-8; in all these figures, it is clearly labeled with reference numeral (1), and shown as having an output beam 140.

To further clarify that the beam 140 recited in the previously amended paragraph [50] of the original specification refers not to the output of fig.3a, b, as inaccurately alleged in the objection, but to the output of the Littrow-stabilized laser diode 1, paragraph [50] has been amended, as set forth above, to add the reference numeral "1" after the phrase "the Littrow-stabilized laser diode", and to include the phrase "of the Littrow-stabilized laser diode 1", after the phrase "the laser output beam 140." These amendments are supported by the wording of paragraph [52] of the specification, as originally filed.

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Furthermore, the amendment to paragraph [50] of the original specification that identifies the beam 140 as the "high-power beam" has a direct support in paragraph [52] of the original specification, which includes the following original wording (emphasis added) "the Littrow-stabilized laser diode 1 ... produces the at least partially collimated *high-power beam 140*". Withdrawal of the allegation of new matter in paragraph 3 on page 2 of the outstanding Office Action is respectfully requested.

With respect to the statement in paragraph 4 of the Final Office Action, the portion of paragraph [52] of the original specification referring to an infrared dump beam, as previously amended, reads (wording added by the amendment in question is underlined) as follows:

"With reference to FIG. 6,... A dichroic filter 165 may be placed at the output of nonlinear element 155 to block the high-power beam, e.g. by reflecting it as an infrared dump beam 175 away from the optical path, and to pass the frequency-converted second beam as the output 170 of the laser apparatus."

FIG. 6 as originally filed clearly shows a dichroic filter 165 splitting the beam incident from the lens 160 into two beams 170 and 175, with the beam 175 being reflected from the dichroic filter 165, and being also clearly labeled in the original FIG. 6 as "IR dump". The abbreviation "IR" in relation to optical radiation is commonly used in the art to mean "infrared".

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Therefore, FIG. 6 clearly discloses an infrared (IR) dump beam 175 reflected from the dichroic filter 165, thereby providing support for the amendment in question to paragraph [52] of the original specification.

In view of the foregoing, Applicants respectfully submit that the previously filed amendments to paragraphs [50] and [52] of the specification as originally filed are fully supported in the application as originally filed and, as such, do not contain new matter. Withdrawal of the objection to the specification in items 2, 3 and 4 on page 2 of the outstanding Office Action is, accordingly, respectfully requested.

In addition to the above-identified amendments to paragraph [50], paragraph [20] of the original specification has been amended to change the wording "less than 19%" to "less than 1%" to correct a typographical error in the text. Also, in paragraph [65] of the original specification, the phrase "will yield IR laser radiation with wavelength of 175- to over 800 nm" have been amended to read "will yield laser radiation with wavelength in the interval from 175 nm to over 800 nm," in order to improve the grammar, and to delete the obviously erroneous term "IR" from the identification of the specified wavelength range.

Claim Rejections - 35 U.S.C. § 112

Claim 1 has been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

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In particular, paragraph 6 of the outstanding office action alleges that Claim 1 is indefinite because "In the present instance, Claim 1 recites the broad recitation less than 10%, and the claim also recites between 1% and 5% which is the narrower statement of the range/limitation."

Contrary to this assertion, the limitations "less than 10%" and "between 1% and 5%" recited in previously presented Claim 1 do not constitute a narrower range that falls within a wider range, as they relate to two different characteristics, or parameters, of the claimed laser apparatus.

The first limitation "less than 10%", which has been alleged as the wider limitation, specifies:

"a bulk transmission grating ... for returning a portion of the at least partially collimated beam back *toward* the laser diode by means of diffraction, *said portion* being less than 10% in power"

Clearly, this is a limitation on a portion of the beam that is returned toward the laser diode, not into the laser diode.

One skilled in the art reading this text will readily conclude that this recitation relates to the power reflectivity of the bulk transmission grating in the direction toward the laser diode.

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The second limitation "between 1% and 5%", which has been alleged to be a narrower limitation, is a limitation on the *optical feedback into the laser diode* that is caused by the bulk grating returning the less than 10% portion of the beam toward the laser diode:

"so as to provide optical feedback into the laser diode between 1% and 5%"

Optical feedback into the laser diode is not the same as a portion of laser radiation returned toward the laser diode. The portion returned toward the laser diode will experience additional losses in the optical path between the bulk grating and the laser diode, before entering the laser diode to provide the optical feedback into the laser diode.

It will be readily appreciated, therefore, that the recited phrases "less than 10%" and "between 1% and 5%" in Claim 1 do not constitute a narrower limitation within a broader limitation, since they refer to two different characteristics of the claimed laser apparatus - 1) a *portion of the incident beam returned toward the laser diode*, and 2) *the optical feedback into the laser diode*.

The statement of the rejection further refers to MPEP § 2173.05(c) stating that "A broad range or limitation together with a narrow range or limitation that falls within the broad range or limitation (in the same claim) is considered indefinite", and the explanation given by the Board of Patent Appeals and Interferences in *Ex pane Wu*, 10 USPQ2d 2031, 2033 (Bd. Pat. App. & Inter. 1989), as to where broad language is followed by "such as" and then narrow language can render a

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claim indefinite. The Board stated that this can render a claim indefinite by raising a question or doubt as to whether the feature introduced by such language is (a) merely exemplary of the remainder of the claim, and therefore not required, or (b) a required feature of the claims.

Applicants respectfully submit that this statement by the Board is not applicable to Claim 1. In the previously presented Claim 1, the limitations in question are not separated by the phrase "such as", cited by the Board, but instead are separated by the words "so as", which are conventionally understood to mean the existence of a functional dependence between two different required claimed features. As such, Applicants respectfully submit that the use of the phrase "so as", rather than the phrase "such as" in Claim 1 makes it clear that both of the limitations, the one that precedes the words "so as", and the one that follows the words "so as", are required features of the claim, that make the claim definite.

Withdrawal of the rejection of Claim 1 under 35 U.S.C. § 112 is respectfully requested.

Claim Rejections - 35 U.S.C. § 103

Independent Claim 1 and Claims 3-6, 8, 12 and 14 dependent thereon, have been rejected under 35 U.S.C. § 102(e), as allegedly anticipated by, or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Suganuma et al. (US Patent Application Publication 2002/0012377, hereinafter referred to as Suganuma et al). Claim 27 has been rejected

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under 35 U.S.C. § 103(a) as being unpatentable over Suganuma et al.

Additionally, Claims 1 and 13 have been rejected under 35 U.S.C. § 102(e) as allegedly anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over Sidorin et al. (US Patent Application Publication 2003/0214700, hereinafter referred to as Sidorin et al).

In the previous response filed on March 14, 2006, Applicants pointed out the manner in which amended Claim 1 is patentably distinguishable over Suganuma et al and Sidorin et al, noting that neither reference discloses, teaches or suggests either a bulk diffraction grating for returning back toward the laser diode less than 10% of the laser beam, or a bulk diffraction grating for providing optical feedback into the laser between 1% and 5%. Moreover, it was pointed out that both Suganuma et al and Sidorin et al teach away from these claim limitations by specifying that the volume hologram (of Suganuma et al) and the diffraction device (of Sidorin et al) have high diffraction efficiencies. In particular, Suganuma et al recites "a diffraction efficiency exceeding 90%" (paragraph [0007]); Sidorin et al teaches in paragraph [0182] that the diffraction device 115 that provides an even higher, up to 100%, diffraction efficiency is preferable.

In paragraph 24 of the Final Office Action, these differences have been ostensibly dismissed on the grounds that "A "diffraction efficiency" ... is what gets transmitted not what is reflected".

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These comments appear to suggest that the high diffraction efficiency of the volume hologram (3) recited by Suganuma et al and of the diffraction device (115) of Sidorin et al, means that the transmissive diffracting devices (3) and (115) transmit most of the light incident thereupon, and diffract back towards their respective laser sources only a small portion thereof. In support of this interpretation of the term "diffraction efficiency", reference is made to the US Patents 4,337,994 by Brasier (Column 1 Lines 58-61) and 6,122,104 by Nakai (Column 11 lines 33-35).

Applicants respectfully submit that the statement in the Office Action that "A "diffraction efficiency" is what gets transmitted not what is reflected" is inaccurate and, in relation to the cited prior art, as well as the current application, is incorrect.

The term "diffraction efficiency", when applied to a diffraction device such as a diffraction grating, is commonly understood in the art as relating to a ratio of intensities, or power, of light incident on the grating and light diffracted from the grating; in other words, "diffraction efficiency" in its most commonly used meaning is the fraction of incident light that is diffracted by the grating under consideration.

When a grating is capable of diffracting incident light in several different directions, these directions are said to be associated with different diffraction orders. Thus, the term "diffraction efficiency" may relate to a particular diffraction order associated with a respective direction of diffraction. In those applications, where the term

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"diffraction efficiency" is not directly and explicitly associated with a particular diffraction order, the term is commonly assumed to be related to the diffraction in a desired direction for the application, which is typically the direction of the first diffraction order. (See, for example, Chapters 9 and 15 of the Diffraction Grating Handbook, 5th edition, published by Richardson Grating Laboratory http://phys-advlab.physics.lsa.umich.edu/Phys441_442/Atomic%20Spectroscopy/DiffGrating.pdf ; also, see e.g. paragraph [0004] of the Suganuma et al).

This commonly understood meaning of the term "diffraction efficiency" is consistent with its usage in the present application, in the cited prior art documents Suganuma et al, and Sidorin et al, and in the US patents of Brasier and Nakai.

The difference between the gratings taught by Brasier and Nakai on one side, and the gratings taught by Suganuma et al and Sidorin et al, is that Nakai, e.g. in Fig.2, and Brasier, e.g. in Figs. 1 and 4, teach gratings (1 and 42, respectively) wherein the useful (first order) diffracted light is transmitted through the grating, wherein Suganuma et al and Sidorin et al teach gratings wherein the useful (first order) diffracted beams are reflected from the gratings. Accordingly, in devices of Brasier and Nakai, the term "diffraction efficiency" relates to the diffracted light (1st order) that is transmitted through their respective gratings, while in devices taught by Suganuma et al and Sidorinn et al, the term "diffraction efficiency", at least in the embodiments referenced in the Office Action, relates to the diffracted light (1st order) that is reflected through their respective gratings.

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In support of the conclusion that Suganuma et al teach a grating that returns back toward the laser *less than 10% of the laser radiation*, as claimed in Claim 1, reference is made to paragraph [0194] of Suganuma et al, which reads as follows:

"[0194] The photopolymer volume hologram has a high diffraction efficiency. The laser can therefore emit a laser beam of any desired wavelength at high efficiency."

Contrary to the rejection, Applicants respectfully submit that this paragraph, when considered in the context of the entirety of the description of Suganuma et al, describes a grating that reflects back toward the laser most of the incident laser radiation, thereby enabling the laser to emit *"a laser beam of any desired wavelength at high efficiency"*.

Indeed, in paragraph [0051], Suganuma et al describe that *"like any type of a volume hologram, the hologram 1 has a high diffraction efficiency, increasing the finesse of the external resonator over that of the ordinary external resonator. This also serves to raise the wavelength selectivity of the external resonator"*.

This statement of Suganuma et al refers to external resonators of external resonator lasers shown in FIGs.3 and 4 (copied below), comprising a laser 2, a collimating lens 3 and a volume hologram 1. In Figure 3, the volume hologram 1 is a reflex hologram, that reflects a portion of the laser beam via diffraction at a prescribed angle towards a mirror 4, which returns light back into the laser diode via a diffraction on the volume hologram 1. In figure 4, hologram 1 is an epitaxial

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volume hologram, that diffracts the laser light back into the laser directly. In both cases, the diffracted light is reflected from the hologram 1, rather than transmitted through it.

Obviously, if having a higher diffraction efficiency would mean that a higher portion of the beam incident on the hologram 1 from the laser 2 is *transmitted through the hologram 1*, as the rejection seems to suggest, rather than reflected toward the laser 2, the finesse of the external resonator of either of FIGs. 4 or 3 would be *decreased*, not increased, leading to a *lower* wavelength selectivity of the external resonator, when compared to the external resonator formed with a grating having a lower diffraction efficiency.

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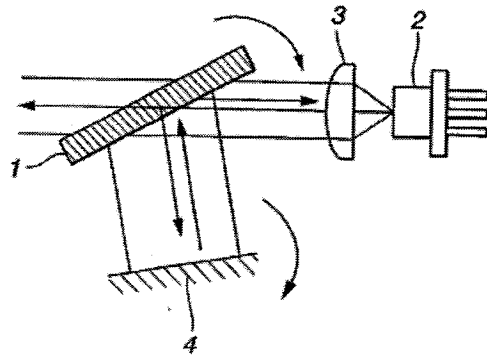


FIG.3

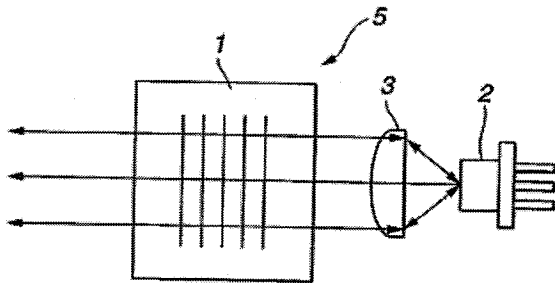


FIG.4

Thus, the statement of Suganuma et al that the hologram 1 has a high diffraction efficiency "exceeding 90%" (parpgraph [0007]) can only mean that it diffracts a larger portion of the incident beam toward the laser 2. This is in direct contrast to Claim 1, which recites that the transmission grating is for returning toward the laser a portion of the laser beam which is less than 10% in power.

It will be readily appreciated, therefore, that Suganuma et al not only fail to disclose all of the limitations of Claim 1, but teach away from the claimed limitation of

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returning back toward the laser less than 10% of the (laser) beam "so as to provide optical feedback into the laser diode between 1% and 5%). As such, Suganuma et al do not anticipate, nor do they make obvious, the invention as claimed in Claim 1. withdrawal of the rejection of Claim 1, as well as claims 3-6, 8, 12, 14 and 27 dependent thereon, is, accordingly, respectfully requested.

Rejections under 35 U.S.C. § 103(a) in view of Sidorin et al

Sidorin et al disclose, for example, in Figure 1A, an external cavity optical source comprising a laser diode 100 coupled through a collimating lens 120 to a transmissive diffraction device 115 providing wavelength selective feedback to the laser diode 100.

In support the allegation that Sidorin et al anticipate, or at least make obvious, the invention of Claim 1, the rejection refers to paragraph [0182] of Sidorin et al reciting theoretical diffraction efficiency of 100%, and states that, in the apparatus of Sidorin et al, the "theoretical diffraction efficiency values near 100% would give less than 10% feedback".

This statement, which Applicants respectfully submit is inaccurate, appears to stem from the misunderstanding of the term "diffraction efficiency", at least as applied in the cited prior art (Sidorin et al).

As pointed out above, the "diffraction efficiency" of an optical grating, according to its commonly accepted

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definition, is a fraction of power of incident light that is *diffracted* by the grating in a specified order or direction.

Sidorin et al in paragraph [0078] clearly state, that "the configuration shown in FIG. 1A is a Littrow configuration in which *the first order diffraction beam is returned by the diffraction device 115 along the same path as the incident beam*" and, further, in paragraph [0187], describe teach that "To maintain diffraction efficiency while keeping the design of the diffraction device 115 relatively simple, *it is best to use the first order of diffraction.*" It is clear from these statements of Sidorin et al, that the diffraction efficiency recited in paragraph [0182] (up to 100%) refers to the beam 147 (FIG.3) that is "returned by the diffraction device 115" toward the laser 100.

Namely, Sidorin et al clearly describe returning a large portion of the incident beam 145 "*by the diffraction device 115 along the same path as the incident beam*", i.e. toward the laser 100. As such, Sidorin et al teach away from the limitation of Claim 1 of returning a portion of less than 10% in power of the at least partially collimated (laser) beam toward the laser diode to provide an optical feedback between 1 and 5%.

Summarizing, it is respectfully submitted that both Sukanuma et al and Sidorin et al teach away from the claimed limitation of the bulk diffraction grating for returning a portion of less than 10% in power of the at least partially collimated (laser) beam toward the laser diode. Withdrawal of the rejection of Claim 1 and its dependent claims over these references is, accordingly earnestly solicited.

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The Rejection of claims 1 and 18-20, under 35 U.S.C. § 103(a) over Bahatt et al. (US 6,600,563) in view of Sidorin et al

In the rejection of Claim 1, it is alleged that Bahatt et al disclose, in Figure 1, a laser apparatus, comprising a laser diode 10 and a transmission grating 50 *wherein the laser diode reflective back facet and the transmission grating form an extended laser cavity*. Applicants respectfully submit that this statement is inaccurate.

More particularly, Bahatt et al disclose, e.g. in figure 1, an optical resonance analysis system using an illumination means 400 that comprises a laser diode 10 and a pre-dispersive grating 50 for dispersing illumination from the diode laser at a plurality of angles toward a sensor means 60.

Nowhere in their specification do Bahatt et al disclose or suggest that *the laser (10) reflective back facet and the transmission grating (50) form an extended laser cavity*, as claimed by Claim 1 of the present invention.

As pointed out in their Response filed on March 21, 2006, the pre-dispersion grating of Bahatt et al is not for the purpose of providing optical feedback into the laser diode, but rather for "*for dispersing the 830-910 nm wavelength range*" toward the sensor means 60 "*to match the resonance angles*", as recited in column 13, lines 40-41 of Bahatt et al. The statement of the rejection points to no portion of Bahatt et al which controverts this statement.

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This rejection further alleges that "*Bahatt's diffraction grating would provide feedback to the laser diode; therefore it does meet the limitation of claims*".

Applicants respectfully submit that there is nothing in the specification of Bahatt et al that supports a conclusion that the diffraction grating 50 would provide feedback to the laser 10.

Indeed, to provide optical feedback to laser 10 and form an extended cavity therewith, the grating 50 must return a suitable amount of the laser light back into the laser. In the configuration shown in FIG. 1 of Bahatt et al, the grating 50 is oriented at about 45 degree angle towards the laser beam, and therefore would not normally reflect any appreciable amount of light into the laser 10, as is required for forming an extended cavity therewith. Indeed, having facets of optical elements oriented at an angle toward the laser beam is a well-known in the art method of *preventing* back-reflections of the light into the laser.

Accordingly, grating 50 is only capable of forming an extended cavity with the laser 10, if specifically designed to *diffract* light back into the laser 10, as in the Littrow configuration. However, there is no such disclosure in the Bahatt et al.

On the contrary, Bahatt et al describe that the grating 50 is "*for dispersing the 830-910 nm wavelength range*" toward the sensor means 60 "*to match the resonance angles.*" See column 13, lines 40-41 of Bahatt et al.

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Accordingly, it is respectfully submitted that Bahatt et al is devoid of any disclosure or suggestion that *"the laser diode reflective back facet and the transmission grating form an extended laser cavity"* as claimed by Applicants. As such Bahatt et al is also devoid of any teaching of a bulk transmission grating disposed for returning a portion of the received beam *"back toward the laser by means of diffraction"*, *"said portion being less than 10%"*, *"so as to provide optical feedback into the laser diode between 1% and 5%"*, as claimed in Claim 1.

It is Applicants' understanding that, in order to establish a prima facie case of obviousness, all of the claim limitations must be taught or suggested by the prior art. The combination of Bahatt et al and Sidorin et al fails to teach or suggest returning a portion of the laser beam back toward the laser, said portion being less than 10%, "so as to provide optical feedback into the laser diode between 1% and 5%", as claimed in Claim 1.

As pointed out at length above, independent Claim 1 recites features that are not taught or suggested by either Bahatt et al or Sidorin et al. As a consequence, it is respectfully requested that the rejections under 35 U.S.C. § 103 of Claim 1 and Claims 18-20 dependent thereupon in view of Bahatt et al, Sidorin et al, and also in view of Naganuma, U.S. Patent No. 6,452,720, cited in connection with Claim 19, be withdrawn.

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Claim 2 has been rejected as being unpatentable under 35 U.S.C. § 103 over Suganuma et al, in view of Cook, U.S. Patent No. 6,432,471.

The deficiencies of Suganuma et al with respect to Claim 1, upon which Claim 2 depends, are addressed above. The secondary reference to Cook discloses a method for generating an anti-reflection coating for a laser diode, using an external cavity laser diode system 16 having a transmissive grating 30, wherein "The lasing wavelength is changed (i.e., tuned) by rotating the grating 30 about an axis 32 perpendicular to the beam axis 34". Like Suganuma et al, Cook fails to teach or suggest returning a less than 10% portion of the laser beam back into the laser "so as to provide optical feedback into the laser diode between 1% and 5%", as claimed in Claim 1, upon which Claim 2 depends. Thus, Applicants respectfully submit that Claim 2 is patentable and requests that the rejection under 35 U.S.C. 103 be withdrawn.

Dependent Claims 9-11, 15-17, and 21-26

In paragraphs 13-21 of the outstanding Office Action, dependent Claims 9-11, 15-17, and 21-26 have been rejected as unpatentable over Suganuma et al, in view of Burns et al. (US H1965H), Hayakawa (US 6,885,687), Yang et al, U.S. Patent No. 6,704,509, Swanson et al, U.S. Patent No. 5,956, 355, Allenson et al, U.S. Patent No. 6,829,278, Ziari et al, U.S. Patent No. 6,215,809, Govorkov et al, U.S. Patent No. 6,614,584, and Daiber et al, U.S. Patent No. 6,816,516, which, in various combinations, are said to disclose various particular features claimed in the dependent claims.

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Applicants respectfully submit that none of the patents cited in the outstanding Office Action, including those referenced in paragraphs 13-21 thereof, discloses or suggests a bulk transmission grating for returning less than 10% of the laser beam back toward the laser diode so as to provide optical feedback into the laser diode between 1% and 5%, as claimed in Claim 1, upon which Claims 9-11, 15-17, and 21-26 depend. Applicants therefore respectfully request that the rejection of these dependent claims be withdrawn.

In view of the foregoing amendments and remarks, favorable reconsideration of this application and a notice of allowance of Claims 1-6 and 8-27 are respectfully requested.

Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Please charge any shortage in fees due in connection with the filing of this paper, including Extension of Time fees, to Deposit Account No. 50-1465 and please credit any excess fees to such deposit account.

Respectfully submitted,

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